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Future ecosystems — ecological balance (ecological impact of disease causing fungi in south-western Australia)

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Abstract

Ecosystems are dynamic not static; however, since European settlement the rates of change have been dramatic and rapid. Entirely new types of disturbances have occurred including land clearance, new grazers, new predators, new pollinators, new weeds and new diseases. All of these have impacted on the ecological balance of native plant and animal ecosystems, and their effects are synergistic not unique.

South-western Australia has unique species-rich and structurally diverse plant communities, supporting a web of co-evolved fauna species. New plant diseases may lead to simpler ecosystems in terms of structure, diversity and function. Remnants will often be severely impacted, and more prone to weed invasion. Larger areas may become dominated by fewer resistant species.

Many susceptible plant species of restricted ranges face the possibility of extinction in the medium term. More widespread susceptible taxa face severe genetic erosion through local extinction of populations in remnants where re-invasion is not possible. Native animal species which rely on the floral diversity for food and shelter may face local extinction, or at least critical reduction in numbers.

Perhaps the greatest challenge facing land managers and those attempting to conserve our wild heritage is to understand, detect and lessen deleterious disturbances from completely overwhelming our remaining bushland, and rendering it more vunerable to disease.

Introduction

All ecosystems are dynamic and change in place and composition over time. Disturbance is a recognised feature of ecosystems, and appears to be vital in maintaining species and community diversity. However, prior to the advent of industrialised European man, this cycle of disturbance and renewal occurred in a setting of continuous bushland. Since settlement in Western Australia and the clearing of land for agriculture, all ecosystems have been rapidly and severely impacted. In the south-west of Western Australia the major change has been the fragmentation of the bush by clearing for other land uses. This has resulted in numerous, often small, isolated bushland remnants many of which appear to have a limited future without careful management. Clearly, fragmentation of ecosystems and its consequences are major challenges facing conservation managers world-wide.

Disease is one aspect of natural population control involved in disturbance and change, but combined with fragmentation it may prove decisive, destructive and unidirectional. This paper mainly deals with *Phytophthora cinnamomi*, but it should be noted that several other diseases briefly mentioned here also pose local severe conservation problems and deserve closer scrutiny.

Symposium on Plant Diseases in Ecosystems: Threats and impacts in south-western Australia.
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Impact

Root cankers:
Phytophthora cinnamomi

Detailed studies in Victoria (the most climatically-similar area) in dry sclerophyll woodlands, heaths and swamps in the Grampians, Brisbane Ranges and Wilsons Promontory by Dawson *et al.* (1985), Kennedy & Weste (1986), Weste (1975, 1981 & 1986), Weste & Law (1973), Weste & Taylor (1971) and Weste *et al.* (1973) have shown that the disease has permanent and severe effects on the structure and floristics of these plant communities. Similarly severe and permanent impacts have been noted in Tasmania (Podger *et al.*, 1990) and Western Australia at Two Peoples Bay (Hart 1983), Cape Arid and Cape Le Grande (Brandis *et al.* 1985), Stirling Range (Wills 1993), the jarrah forest (Shearer & Tippett 1989) and the Banksia woodlands of the Swan Coastal Plain (Podger 1972, Shearer & Hill 1989, Shearer 1990). Potentially major impacts can be expected in the heathlands north of Perth (Hill 1990), and in the understorey of many communities of the southern forests (Shearer 1992). The western edge of the wheatbelt and localised populations of proteaceous heaths in suitable catchments in this entire region could also be at risk.

In general, the ecological balance which might be achieved in future ecosystems after major disease impact is likely to be reflected in simpler communities in either structure (loss of susceptible dominants) and/or floristics (loss of susceptible species), hence a net local loss of biodiversity. These effects

are most widespread and severe in the south coast heathlands of Western Australia, from Augusta to Cape Arid. Since this region also contains the highest proportion of vertebrate pollinated flowering plant species in the world (Keighery 1982), many of which are Proteaceae, and susceptible to dieback, secondary effects will also be severe on the diversity of animal communities (Friend 1992) in this area.

Bird-pollinated plants often dominate our flowering heathlands in spring, with their large and brilliantly coloured flower; many of these species are highly susceptible to dieback and are replaced by wind-pollinated resistant sedges, a dismal sight to any honeyeater or tourist. Dieback is likely to reduce local populations of these birds. Insects reliant on susceptible species will also face significant reductions in food sources (*e.g.* the specific bee pollinators, *Leioproctus pappus* of *Conospermum incurvum*, *Euryglossa morrisoni* of *Verticordia niteus* and *Euryglossa aurea* of *Verticordia aurea*; Houston 1992), but there are few data on the extent of this aspect. The effects on soil organisms, including fungi (see Malajczuk & Pearce 1994) is almost completely unknown, but it must be considerable.

The second major impact will be on the hundreds of bushland remnants containing susceptible communities in an arc between Moore River, Kojonup and Esperance. In the studies noted above, the affected areas are within large areas of native vegetation, enabling immigration of resistant taxa, with refuge areas often present for susceptible taxa. In small isolated remnants there is little chance of recruitment from neighbouring remnants, no refugia and local extinction is the major consequence, accompanied by weed invasion. For example, the Swan Coastal Plain Survey has placed over 500 permanent vegetation quadrats in bushland between Gingin and Dunsborough, and has compiled total flora lists for most reserves in this area and on sections of the escarpment. Quadrats at Twin Swamps, Bullsbrook, and Cardup Nature Reserves, shown a major decline in species diversity in communities invaded by *Phytophthora cinnamomi* and a major increase in weed invasion following severe impact by *Phytophthora*. Average species diversity declined from 69 species to 39 at Cardup or from 49 to 25 at Twin Swamps, and weed species increasing from an average of less than 2% to over 50% of species records at some sites in Twin Swamps. The disease removes susceptible dominants and understorey species, hence opening the community to invasion by resistant annual and grassy weeds. Flora surveys indicate that local extinctions of many susceptible understorey taxa such as *Banksia meisneri* var *adscendens*, *Verticordia nitens* and *Lambertia multiflora* var "darlingensis" are likely to occur over the next 5 years at Ruabon, Bullsbrook and Cardup Nature Reserves respectively unless urgent remedial action is taken. Remnants with service corridors through them or with wetlands in or adjacent to the remnant appear to suffer the highest impact, with disease spreading from the wetland or corridor. These remnants are likely to lose their Banksia woodlands entirely, as the dominant Banksia trees become locally extinct. At a species level, the disease has the potential to lead to at least the localised extinction of highly susceptible species.

A number of recent publications list and publicise the taxa under the greatest threat (Conservation and Land Management 1992, Curry 1992, Curry & Kelly 1993, Keighery 1988 a, b, 1991, 1992). Eleven taxa are under greatest threat with most or all populations infected (Table 1). Seven of these are considered under threat of extinction in the wild, and the four other taxa are being monitored to determine their status and management options.

Table 1
Taxa requiring urgent management action to lessen the impact of Phytophthora

A) Taxa under threat of extinction in the wild in the medium term, all populations impacted by disease:

Andersonia axilliflora
Andersonia sp (Two Peoples Bay)
Andersonia sp (Mt Lindesay)
Banksia brownii (Both forms)
Dryandra "montana"
Isopogon uncinatus
Lambertia echinata

B) Taxa with most populations infected by disease, potentially at risk of extinction in the wild:

Calytrix breviseta ssp *breviseta*
Conospermum caerulescens ssp *"adpressum"*
Dryandra sp 30
Lambertia orbifolia

Current research and management has centred on protecting stands of the most threatened species (currently *Andersonia* species and *Banksia brownii*) by phosphonate spraying and collection of germplasm material (of all taxa) for *ex situ* long term storage. *Ex situ* germplasm collections are a last resort but in a number of cases may be the only means of preventing total extinction of a species. Information on the effects of disease on many other restricted and potentially threatened species, such as the mountain bells (*Darwinia* species), *Adenanthos detmoldii*, *A.pungens*, *Persoonia micrantha*, *Isopogon uncinatus*, *Banksia occidentalis* ssp. *formosus*, and *Petrophile latericola*, is urgently needed to set priorities and develop strategies for their conservation and management. More widespread susceptible species, such as *Banksia coccinea* and *Lambertia propinqua*, are suffering significant genetic erosion through the local extinction of populations and reduction in population size. Other species such as *Lambertia orbifolia*, *Banksia brownii*, *Banksia illicifolia* and *Adenanthos barbigerus*, are in danger of losing genetically and morphologically distinct races. Again the ecological balance is being shifted to less complex communities, by the loss of regional genetic and specific diversity (geographically restricted taxa and localised population divergence appear to be a feature of plant communities in south-western Australia; Hopper & Coates 1990).

Other *Phytophthora* species

Five other species of *Phytophthora*, namely *P. citricola*, *P. cryptogea*, *P. dreschleri*, *P. megasperma* and *P. nicotiana* have been identified from dead and dying native vegetation. All of these species can have localised severe impact, and probably pose a major threat to at least some local populations of susceptible flora (such as the localised, declared rare species, *Adenanthos ellipticus* on East Mt Barren) and isolated remnants.

Wood rots

Armillaria luteobubalina is the major species of wood rot, with a wide and diverse host range, often from groups resistant to *P. cinnamomi*, and in habitats usually at low risk from root rots *e.g.* Coastal dunes and Spearwood sands (Shearer & Tippett 1989). The impact of disease caused by this fungus on a local scale in Granite heath,Wandoo and Coastal heath can be severe, hence its greatest impact will be on remnants, where it may cause local extinctions and enhanced weed invasion. Localised rare species could also be at risk. Detailed long term studies are required on the effects of this disease, since it is a native species, to understand its role in native plant communities.

Stem and branch cankers

Currently the major concern is the canker *Cryptodiaporthe* sp. which affects a broad range of Proteaceae, often causing death of the plant. *Banksia coccinea* populations are being heavily impacted by this canker, and this species faces localised extinction in the Albany area. The only known population of *Dryandra* sp (Kamballup) is infected with canker (Wills, *pers comm*), and requires monitoring. A series of other cankers can cause dieback and death and loss of overstorey Eucalypt species, including Marri and Red Flowering Gum, Wandoo and Tuart. These diseases could prove severe in remnants, preventing the replacement of species after loss of the parental trees. These cankers appear to be a response to various types of disturbance and/or enviromental factors such as drought stress, and their long term impacts are unknown.

The future

The symposium organisers requested that we speculate, based on current knowledge what the ecological balance of future ecosystems would be under current trends of diseease spread and impact. Our potential future is major impacts of these diseases in south western Australia, as presented below.

The combined fragmentation and increasing levels of disturbances will inevitably result in a loss of biodiversity. This will result, through the changes in community structure favouring resistant species, in the extinction of local populations of numerous species and the subsequent loss of genetic diversity, the likely extinction of many rare and geographically-restricted susceptible species, secondary species loss of both plants and animals through lack of pollinators, food plants and shelter, severe genetic erosion of widespread susceptible taxa, and a loss of scenic values to the public and tourists. Currently the ecological balance seems to be shifting towards simpler, weed-invaded and less visually appealing plant and animal communities, that may lack many of their uniquely Western Australian features. There seems little doubt that introduced diseases are hastening this trend.

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